

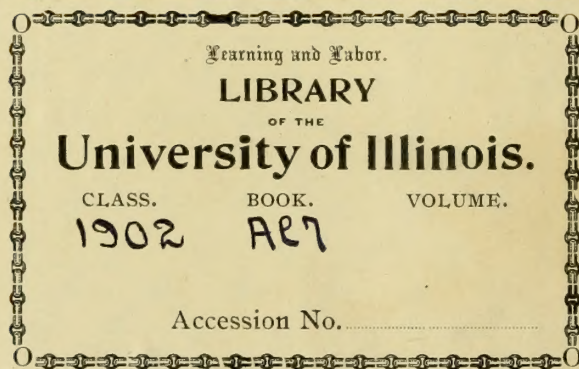
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Cement Walk
Construction

Civil Engineering
B. S.

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CEMENT WALK CONSTRUCTION

BY

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THIS IS TO CERTIFY THAT THE THESIS PREPARED UNDER MY SUPERVISION BY

Fred Albert Alsbach

ENTITLED

Cement Block Construction

IS APPROVED BY ME AS FULFILLING THIS PART OF THE REQUIREMENTS FOR THE DEGREE

OF

Bachelor of Science in Civil Engineering

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HEAD OF DEPARTMENT OF

Civil Engineering

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Cement Walk Construction

Cement walks are rapidly gaining public favor, on account of both cheapness and durability; and therefore the writer thought it would be profitable to discuss the subject of cement walk construction.

Subgrade

The subgrade deserves special attention, as many, if not most, failures can be traced directly to its improper preparation. The soil should be removed ordinarily to a depth of twelve inches; but if it is soft or of a vegetable nature it should be removed to a depth of at least eighteen inches.

After the earth has been removed, the subgrade should be compacted so as to prevent future settlement. For compacting the soil, an iron roller about twenty-four inches wide and weighing four hundred pounds, or iron rammers having a face about six

or eight inches square and weighing² forty pounds, will be found to give satisfactory results-if properly used. The rammer gives better results, because if there are any spots which need more compacting than others, they will be more easily detected by ramming, than rolling, and further because the rammer has smaller dimensions and would more easily fit into any such place over which a roller might pass without consolidating it. Precautions must be taken to compact firmly the soil over water pipes, sewers, etc., as it may not have been properly replaced at the time such mains were laid and might settle and produce fractures in the walk.

Foundation

When the subgrade has been properly prepared, it is ready to receive the foundation, which usually consists of gravel or cinders. There is scarcely any difference in the merits of these materials for this purpose, and it is usually the supply that decides

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the choice. The foundation is partly to afford drainage, and partly to prevent the heaving action of the frost; and therefore the material employed should not contain much, if any loam or clay.

In laying the foundation care should be taken to place the material properly and compact it so that no settlement may take place. The material is put down in four- or six-inch layers, care being taken to spread it evenly. In case cinders are used, they should be thoroughly moistened so as to compact well. Each layer should be compacted as it is put down.

Base

When the foundation is thus built up to the desired height, it is ready to receive the base, which consists of a layer of concrete from four to six inches thick. The concrete should be one part good Portland cement, two parts of sand, and six parts of gravel or crushed stone. This proportion may be varied de-

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pending upon the quality of cement
used and the percent of voids in
the gravel or broken stone.

The service demanded of a
walk is quite severe, both on account
of the abrasion by the feet, and also
on account of the effect of frost;
and, as a rule, natural cement is
not sufficiently strong for this
purpose.

In mixing the concrete, the
proper amount of sand is spread
out on a platform having dimensions
of say six feet by ten feet, and the
cement is spread on top of the sand
as evenly as possible. The sand and
cement are then mixed with a hoe
or by turning and returning with
a shovel. The mixing can be done
more economically with the shovel
than with a hoe; but the effectiveness
of the shovel depends greatly upon
the method of using it. The shovel
should be so used that the sand
and cement will run off in such
a way as to mix thoroughly; but

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owing to the difficulty of getting laborers to do this, engineers often specify that hoes shall be used. Good results can be obtained with the hoe by unskilled laborers. When the shovel is used two or three turnings - if skillfully done - will thoroughly mix the ingredients.

Water is next added - preferably with a spray so as to prevent the washing away of the cement and also to get the mixture uniformly wetted. Care must be taken not to use too much water, as an excess is a source of weakness. The mortar is then turned with a shovel until it is of a uniform consistency. The aggregate, which may be broken stone, gravel, etc., is now added and the whole mass is then turned three or four times, or until each fragment of rock is covered with mortar. Before the aggregate is added to the mortar, it should be thoroughly wetted, especially if it is limestone or sandstone, since

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either one has great avidity for water and if not moistened enough will absorb water from the mortar and prevent its setting properly.

After mixing, the concrete is placed in the forms in a layer from four to six inches thick. The forms are made by placing two-by-four-inch scantlings along the sides of the trench, stakes being driven on either side to keep the form in position while the concrete is being placed. Care must be taken in placing concrete in the forms not to let the mass fall too great a distance or the ingredients may become more or less separated. The concrete should be compacted with an iron rammer, which should have a face about six or eight inches square and weigh about forty pounds. Especial care must be taken to give the edges against the forms a thorough ramming. This is generally neglected because of the care necessary in tamping near the edges, and the liability

of the form's being pushed out of place. ⁷

Wearing surface.

Immediately after the base is finished and before it has had time to set, the wearing coat should be put on, which consists of equal parts of sand and cement. The sand should contain no pulverized clay, loam, etc., because they will prevent the adhesion of the cement to the stone; and should contain no nodules of clay or friable stone, because these lumps pulverize and wash out, and thereby give the surface a pitted appearance.

The cement employed for the wearing coat should be the same as that for the base. If one kind of cement is used for the base and another for the wearing coat, the bond may not be perfect, because of the difference in the time of set of the two cements, or of one cement's expanding more than the other, the result being that the

wearing coat becomes detached from the base. To replace the wearing coat after it has once been torn off is a very difficult task; and, even when once replaced, it is liable to fail again in the same way for the reason just stated.

In making the mortar, the proper amounts of sand and cement are put in a box and thoroughly mixed. The dry ingredients are then moistened by sprinkling, and thoroughly mixed so as to make a smooth mortar.

The mortar is then spread evenly on the base, and leveled off with a straight edge run upon the tops of the forms previously brought to the proper grade, and then smoothed off with a trowel. It is allowed to stand until it has begun to set, which with most cements is indicated by the exudation of water, when it is troweled again and polished. This is called hard finishing. The wearing coat should

not be disturbed by trampling after⁹ the initial set since it produces hair cracks. As soon as any part of the walk is completed, it should be covered and be kept moist by sprinkling, for a period of at least six or eight days. During this time it must be suitably barricaded to prevent its use.

The thickness of the wearing coat is determined by the amount of traffic to which the walk is to be subjected; and usually one half to three fourths of an inch is considered sufficient for the residence portion of the city, and one inch for the business portion.

The finished surface should have a slope of about one fourth of an inch in a foot for drainage. Where the walk is along the side of a building, as it would be in the business portion of the city, the slope should all be towards the curbing. In a park or in the residence district, it is customary

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to make the walk level transversely in which case if the walk is approximately level longitudinally, the small depressions of the surface retain water which makes the walk uncomfortably wet. This can be remedied by making the center a trifle higher than the sides. To give the surface a slope towards both sides, a templet having its under side cut to conform to the desired cross section, is used.

Care must be taken in replacing the earth along the completed walk so that it is a little below the level of the walk and has a slope from it. For if this is not done, water will continue to drain from the soil and flowing over the walk will keep it wet for an unnecessarily long time.

To make allowance for contraction the concrete should be laid in blocks four or five feet square. One plan of securing a separation of the adjacent blocks is to lay every

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other block, returning to lay intervening blocks when the first have set sufficiently to allow the removal of the partitions. Sometimes water-proof paper is placed between the blocks to keep them from adhering together. Still another method is to cut slits in the sides of the forms every four or five feet and insert iron plates about three-sixteenths of an inch thick, thus dividing the area to be occupied by the walk into box-like spaces, which are filled to the required depth with concrete. When the walk is sufficiently hard, these plates are removed and the spaces filled with dry sand. The first method is the best and is most frequently used. The blocks having been laid closely have sufficient space left for expansion except possibly in very extreme temperatures, and do not leave large spaces after contraction. The edges of the walk should be rounded to a radius of about one half inch, which is done very neatly with a special tool called a former.

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at crossings of unpaved streets the thickness of the base of the walk should be increased two or three inches and that of the wearing coat one half to one inch. There are two methods of protecting the edges; a four-by-six-inch white oak or other hard wood, curbing is firmly fixed at each side of the walk, or the base may be extended on each side and given a batter of about one to one.

Where alleys and private driveways cross the sidewalk, the edges of the latter should be faced to the bottom of the concrete, with the cement like that used on the wearing surface, so as to give additional strength and prevent possible damage by wheels.

At all street crossings, alleys and driveways the surface should be roughened to afford a good foothold. The desired foothold may be produced by making impressions, about one eighth of an inch deep, every three or four inches parallel

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to the direction of the walk, with a bar having a thickness of one fourth inch.

There has been some complaint against the cement walk on the ground that its white color is very trying to the eyes, especially when the sun is shining brightly. Fortunately there is a remedy. The walk may be given any tint or color by using the proper coloring materials. For example, if a gray surface is wanted, Germantown lampblack is used in the proportions of two pounds per barrel of cement. This is a very cheap and effective coloring material, but is very hard to mix with the cement so as to secure a uniform shade. To give a black color forty-five pounds of manganese dioxide per barrel of cement is used. If a blue surface is desired, nineteen pounds of ultramarine is used, while a green color can be obtained by using twenty-three pounds of ultramarine. However it must be remembered that

the mortar is usually somewhat¹⁴ weakened by using coloring materials, and also that if they are used, they must be thoroughly mixed with the cement before moistening it, so that the color of the mortar will be uniform.

One of the occasional defects of a cement walk is that the surface is slippery. This may be due to either of two causes or to both. First, if the cement is very finely ground and is mixed rather wet, the fine cement may flush to the top and give a surface which is slippery. Second, if the cement is moderately fine and the mortar is very rich, tamping may flush neat cement to the top and make a slippery surface.

Cost

The cost of cement walks will depend upon the locality, but ordinarily the best grade of walks are built for 11 to 13 cents per square foot for a three-inch walk and from 13 to 15 cents for a four-inch walk.

The following is a rough estimate of the cost of a walk having an 8-inch foundation of cinders, a 3-inch base composed of 1 cement, 2 sand, and 6 broken stone; and a wearing coat of 1 cement and 1 sand. From Baker's Masonry Construction, page 112 h, The quantities of materials necessary to make one cubic yard of rammed concrete are:

Cement	0.92 bbl.
Sand	0.30 cu. yd.
Broken Stone	0.90 cu. yd.

This will lay the base for 108 square feet of walk. The mortar for the surface coat of this area will require 1.27 bbl. of cement and 0.21 cu. yd. of sand; and the foundation will require 2.67 cu. yd. of cinders. Therefore the total amount of material required for 108 square feet of walk is:

Cement	2.19 bbl.
Sand	0.51 cu. yd.
Broken Stone	0.90 cu. yd.
Cinders	2.67 cu. yd.

The cost of materials delivered will then be about as follows:

Portland Cement	2.19 bbl @ 2.00	# 4.38	16
Sand	0.51 cu. yd @ 1.00	0.51	
Broken Stone	0.90 cu. yd @ 1.60	1.44	
Cinders	2.67 cu. yd. @ 0.50	<u>1.34</u>	
Total		# 7.67 or	

7.1 cents per square foot.

The cost of labor will be based on the assumption that eighteen men can lay twelve hundred square feet of walk, which is a fair average. The following is the cost of the labor per day of ten hours:

1 foreman	@ \$5.00	\$5.00
1 form setter	@ 2.00	2.00
2 finishers	@ 4.00	8.00
14 laborers	@ 1.50	<u>21.00</u>
Total		\$36.00 or 3

cents per square foot. This makes the total cost of the walk exclusive of forms, tools, and profits 10.1 cents per square foot, which agrees reasonably well with the prices stated above.





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